Method and Apparatus for Fastening Components to Initially Closed Hollow Profiles

The invention relates to a method for fastening components to initially closed hollow profiles, according to the preamble of claim 1, and a device for that purpose according to the preamble of claim 15.

A method of this class, as well as a device of this class, is known from DE 196 19 626 C2. In it hangers are affixed to a hollow profile such that both the hanger and the hollow profile are placed in engravings of a high internal pressure forming tool and then the section is subjected to a high internal fluid pressure. Under this pressure the material of the hollow profile flows radially outward and at the location of the hanger it flows conformingly around the surface of the latter which has an undercut shape so that an interlocking bond is established between the hanger and the hollow profile. The described fastening of the hanger to the hollow profile is possible, however, only within the expanded area between the axial sealing, punches that close the ends of the hollow profile. Furthermore, the flexibility of the method is limited by the fact that the shape of the high internal pressure forming tool permanently establishes the shape and location of the bond, so that in the case of different requirements as to the position and kind of the interlocking bond different tools are necessary. The result is great expense and investment in the device.

The invention is addressed to the task of improving a method of that kind and a device also of that kind so that a secure fastening of the component to the hollow profile is made possible in a simple manner, regardless of the point of fastening.

The problem is solved according to the invention by the features of claim 1 with regard to the method and by the features of claim 15 in regard to the device.

Inasmuch as an external pressure is applied to the adjacent walls of the hollow profile and hanger by means of a pressure medium and thus they are forced inward into the interior of the hollow profile thus forming a double-walled indentation, a clamping of the walls is achieved which assures a secure fastening of the hanger to the hollow profile. This indentation is possible axially and radially at any point on the

hollow profile and is freed of any specific shapes of the receiver of the hollow profile and hanger, so that not only the receiver but also the entire device can be configured in a very simple manner. With the method of the invention a simple possibility of fastening is offered that is reliable and practical for hollow profiles that are to be fastened together, which otherwise can not be fastened together in a reliable manner, especially hollow profiles shaped by internal high pressure with attachments or in some cases to other hollow profiles made in the same manner.

Appropriate developments of the invention can be found in the sub-claims; otherwise the invention is further explained below with the aid of several embodiments represented in the drawings, wherein:

Figure 1 is a lateral longitudinal fragmentary section of a device of the invention with a plunger introduced into a hollow profile and having a punch which can be inserted from the exterior and can run on the walls of a hollow profile and component.

Figure 2 is a fragmentary cross section of the device of Figure 1 with the plunger in the piercing position with a mandrel of undercut shape.

Figure 3 shows an expandable plunger of a device according to the invention in a lateral longitudinal cross section.

Figure 4 shows a device according to the invention in a lateral longitudinal cross section with a plunger in the piercing phase and with a mandrel from Figure 3 spread out in the piercing position.

Figure 5 shows in a lateral longitudinal section a device according to the invention with a bipartite mandrel and a fluid pressure medium for the inward forcing.

Figure 6 shows in a lateral longitudinal section a device according to the invention with a bipartite mandrel with pinching action on the material of the walls to be joined.

Figure 7 shows in a lateral longitudinal section a device according to the invention with an elastic skin introduced into the hollow profile.

In Figure 1 there is shown a device for fastening a component 2 to an initially closed hollow profile 3. The hollow profile 3 and the component 2 are held in a receiver here not further shown, with their walls 4 and 5 placed against one another. In this case it is desirable for the assembly process and for a simplified configuration of the receiver if the wall 5 of the component 2 is matched to the contours of the wall 4 of the hollow profile 3. The wall 5 of the flat component 2 is here formed by a flange projecting at right angles. For assembly, a metal mandrel 6 of the device 1 is inserted into the hollow profile 3 and on the circumference of the mandrel a gap 7 open in the direction of insertion is formed. The axial opening of the gap 7 assures the easy withdrawal of the mandrel 6 after the assembly is completed. This gap 7 comes to rest at the location of the walls 4 and 5 which are to be assembled. Then a plunger 8 forming the pressure medium arranged according to the invention locally outside of the hollow profile 3, opposite the gap 7, is driven by a hydraulic, pneumatic, electric motor, electromagnetic or mechanical drive connected to the back of the plunger 8 in the direction of the arrow directly against the wall 5 and indirectly against the adjacent wall 4. As the movement continues, the massive cylindrical plunger 8 pushes the walls 4 and 5 into the gap 7, which thereby forms a molded image of the mandrel 6 serving as a die.

Although in this case a certain interlocking clamping together of the walls 4 and 5 is achieved, it is desirable if the walls 4 and 5 are forced by the plunger 8 into the gap 7 such that they are forced against the wall 9 of the gap in order to improve the clamping in the manner of a press fit (Fig. 2) and in addition to the shape interlock to achieve a friction lock which holds the walls 4 and 5 securely, i.e., for release with difficulty, against one another. In this case the wall of the hollow profile 3 that is nearest the gap conforms to the shape of the gap wall 9. The double-walled indentation 10 formed by the pressing action can have substantially straight mantle lines. The gap 7, however, can also be formed with undercut surfaces, especially in the manner of a dovetail 11. Thus, on account of the counterpressure exercised by the gap wall 9 outwardly from the interior 12 of the hollow profile 3, undercuts 13 and

14 are formed on the walls 4 and 5 by the forcing in and compression of the walls 4 and 5 into the gap 7. For that reason the walls 5 of component 2 are anchored against radial removal in the wall 4 of the hollow profile. In the present embodiment the component 2 is fastened with its wall 5 outside on the hollow profile wall 4. However, it is also possible within the scope of the invention in the same way to position the wall 5 of component 2 inside of the hollow profile 3 and fasten it on the inside of its wall 4. The mandrel 6 must then only be reduced in its diameter. With the above variant it is possible in a simple manner to fasten the component 2 also to the circumference of the ends of the hollow profile 3 – including, in the extreme case, the outer edge of the hollow profile 3 – which is not possible or possibly only with difficulty with the method described in the cited state of the art. It is furthermore conceivable, instead of the cylindrical shape of the plunger 8 to use a plunger configuration in which the tip of the plunger penetrating into the interior 12 of the hollow profile 3 is of spatulate shape. If the plunger 8 is now forced with the walls 4 and 5 into the gap 7, the walls do not entirely fill out the shape of the gap 7 with the plunger 8 in its axial end position. By rotating the plunger 8 by 90 degrees the wall material of walls 4 and 5 is forced into the gap 7 such that it is completely filled up and the walls 4 and 5 are made to conform to the shape of the gap. Then the plunger 8 is turned back 90 degrees and can then be easily removed from the gap 7 and the indentation 10 in the wall. Due to the complete conformity of the walls 4, 5 in the gap 7 the desired undercut is optimally shaped to match it, so that the clamping together of the walls 4 and 5 is improved and thus their lock onto one another is improved.

In another embodiment according to Figures 3 and 4, a variant of the invention that is advantageous due to their simple configuration is illustrated. The receiver in this case forms a high internal pressure forming tool 15 into which one or more plungers 8 spaced axially apart from one another are integrated, which are displaceable in guides 16 as indicated by the vertical double arrow. It is indeed conceivable for the plunger 8 to force the walls 4 and 5 into the interior 12 of the hollow profile 3, operate against atmospheric pressure in the hollow profile 3, after which a high fluidic internal pressure is created (Fig. 4, I).

It is a more economic process and shortens the cycling time, however, if the hollow profile 3 is under high internal pressure while the plunger 8 is forcing the walls 4 and 5 inward. The counter pressure which would be created in the foregoing example against the plunger 8 and the walls 4 and 5 by contact with the notch wall 9 for the forming operation is here provided by the high internal pressure. On account of the forces of the internal high pressure and the plunger 8 acting on the face 17 of the indentation, a sideways displacement of the material of the hollow profile and component, rendered fluid by the high internal pressure, takes place. The end face 17 is made thinner as a result, leading to an accumulation of the hollow profile and component material in the edge area 18 of the end face 17. This has the effect that all around in this area 18 undercut areas form in the indentation 10, so that, in a manner improved beyond the preceding embodiment, the result is a junction similar to a through-joint, which is inseparable in any direction (axial and radial).

A more intense formation of the undercut surfaces is achieved by using a plunger 8 according to Figure 3, which can be spread open at its end 19 facing the hollow profile. This end has a central axial bore 20 which tapers toward the end 19 facing the hollow profile and ends there. Depending on the elasticity of its material in the area of the taper, the plunger 8 is provided at a place on its circumference with an axial slot 21 to provide for the outward expansion of the end 19, which scores the bore 20 over its entire length. In the bore 20 a pin 22 is guided for the displacement indicated by the double arrow; the pin 22 has at its bottom end 23 wedging surfaces 24 by means of which, when it is driven downwardly through the taper in the bore 20, it comes in contact with the bore walls and drives apart the slotted sectors of the end 19. In this manner, as indicated by the two arrows, when the plunger 8 reaches the end in the area of the face 27, both the hollow profile and the material of the indentation 10 are forced radially apart causing the undercut surfaces to be enlarged (Fig. 4, II). In this way the match between the walls 4 and 5 and thus their mating with one another is improved. After the desired undercut's formation has been achieved, the pin 22 is withdrawn, after which the end 19 returns by its elasticity to its starting position, so that the plunger 8 can be removed from the indentation 10.

In an alternative to the two embodiments described, in the case where the receiver is in the form of a high internal pressure shaping tool 15, a mandrel 6 can be driven into the hollow profile 3. In this case the mandrel 6, in a dual function, can advantageously form both the matrix for the plunger 8 and the axial sealing plunger of the tool 15.

It has been assumed up to now that the forcing means is the plunger 8. In another embodiment the forcing means, however, can also be a fluid pressure column 25, as seen, for example, in Figure 5. For this purpose a passage 27 is formed in the receiver, which in this case is likewise an internal high pressure forming tool 26, and is connected outside of the receiver to a pressure generator, and terminates at the walls 4 and 5 in the receiver. The passage 27 is sealed in the marginal area 28 of the receiver by at least one sealing ring 30 beside its opening 29. The pressure column 25 causes virtually no wear on the device 1 and has the additional advantage that the pressure on the walls 4 and 5 can be adjusted very finely and quickly and can be continually adapted to the desired sequence of the pressure injection process. In the present embodiment according to Figure 5, a mandrel 31 is introduced with little free play into the hollow profile 3. In order to form undercut surfaces all the way around the edge 19 of the end face 17 in the indentation, the recess 32 of the mandrel 31 is trough-shaped – i.e., continuous all around – with a dovetail-like cross section. With the pressure column 25 the walls 4 and 5 are forced into the recess 32 until they contact the wall 33 of the recess. The flexibility of the hydraulic fluid is an advantage to the accurate mating of the walls 4 and 5 with the shape of the indentation, because in contrast to the limited ability of a rigidly shaped plunger, it is able to follow the progress of the impression in all directions. The pressure is applied, therefore, directly by the driven hydraulic fluid.

After the shaping of the indentation 10, in order to remove the mandrel 31 from the forming tool 26 with the release of the undercut surfaces, the mandrel 31 is divided into two parts 34 and 35 along its length. Each part 34 and 35 has a section of the recess 32 which is formed at the face 36 of each part 34 and 35, so that when the

two ends 36 are in contact with one another the whole recess 32 is the result. To assure that the two parts 34 and 35 will be together during the impressing process it is desirable to screw the two parts 34 and 35 together. After the indentation 10 has been completed, the screw fastening is released and the two parts 34 and 35 are drawn in opposite directions out of the hollow profile 3 and the forming tool 26. Alternatively, parts 34 and 35 can be driven by hydraulic cylinders and held securely in the end position within the hollow profile 3. This certainly shortens the cycle in comparison with screw fastening, but requires expensive equipment. Furthermore, it is alternatively conceivable to hold the two paarts 34 and 35 together in a simple manner with a clamping device, which can be released quickly if necessary, after they reach the end position against one another.

To expedite the formation of the undercut surfaces, and for improvement in the uniform filling out of the radii of the recess 32, and thus to achieve optimum mating between walls 4 and 5, the mandrel 31 has an axial fluid passage 37 from which a radial passage 38 branches off, which leads into the recess 32 at its bottom 39. Passages 37 and 38 can be only in one of the parts 34 or 35, or – as shown in Fig. 5 – pass through part 34 at passage 37 and terminate in part 35, and be formed as regards passage 38 by an opening at both ends 35 of parts 34 and 35. By feeding a high-pressure fluid through passages 37 and 38 the walls 4 and 5 are made to flow, so that, being driven by the fluid pressure column 25 into the corner areas of the recess 32, they can conform to the walls of the corner areas of recess 32. The variant described can be used, on account of its localized fluid pressure, also wherever some other deformation of the hollow profile 3 is not desired.

Another advantageous variant is shown in the embodiment seen in Figure 6. Unlike the variant in Figure 5, the recess wall 33 of parts 34 and 35 have undercut surfaces 41 as seen in longitudinal section. Instead of the fluid pressure column 25, a hollow or solid plunger can be used, as also in the case of the variant in Figure 5. In order to press the wall material of walls 4, 5 into the recess 32 such that it will come into conforming contact with the undercut surfaces 41, first an indentation of shallow depth is produced by the fluid pressure column 25 or by the plunger 8 in the two

walls 4 and 5. The two parts 34 and 35 have their faces 36 still spaced apart from one another at this time. After the indentation is produced, the two parts 34 and 35 are driven together in the directions of the arrows, while the wedge-shaped closing edges 42 of parts 34 and 35 drive the material of walls 4 and 5 and pinch them. In this pinching action the wall material applies itself simply to the undercut surfaces 41 until the two faces 36 come in contact with one another. To allow this to be accomplished surely, so that no wall material gets on the faces 36, care must be taken to see that either the indentation is small enough when parts 34 and 35 begin to move toward one another, or the bottom 39 of the recess 32 must be at least so deep that the wall material of the indentation 10 will not come in contact with the bottom 39 until the faces 36 of parts 34 and 35 are in contact with one another. The described variant method has the advantage that, for the formation of the indentation 10, wall material is fed axially by the parts 34 and 35, so that harmful effects are prevented. Furthermore, due to the active axial action of parts 34 and 35 on the wall material, the variant is a method as to how a virtually complete mating together of two walls 4 and 5 with undercut surfaces 41 can be achieved.

In an additional advantageous embodiment according to Figure 7, the component 2 can be in the form of a hollow profile which is assembled together before it is fastened to the hollow profile 3. A tubular elastic bellows 40 can be introduced, as shown in this embodiment in Figure 7, into the hollow profile 3 which here is internal, and it supports the hollow profile 3 while the plunger 8 thrusts internally, while within the bellows 40 a fluidic high internal pressure is applied, which on the one hand expands the hollow profile 3 during the procedure of pressing with the plunger 8, while within the bellows 40 a fluidic high pressure is applied, which expands the hollow profile 3 together with the tubular component 2, and in cooperation with the plunger 8, as already described in the embodiment in Figures 3 and 4, forms the undercut surfaces of the indentation 10. The bellows 40 thus forms part of a matrix which additionally consists of the pressure medium itself, into which the walls 4 and 5 can be pressed. With the bellows 40 it is brought about that the hollow profile 3 is not wetted by the pressure medium, which is desirable for easily corroded materials. Furthermore, the bellows 40 prevents hydraulic fluid from leaking out uncontrolled in the event of any kind of crazing or cracking in the indentation 10, and provid for any

unwanted loss of pressure which would undermine any reliable shaping of undercut surfaces. Instead of the bellows 40 the device 1 can contain a diaphragm fastened, for example, to the axial plunger.

For additional strengthening of the bond between the walls 4 and 5, they can be brushed or coated with an adhesive before they are brought together, the tackiness of the adhesive being activated, preferably by heat treatment after the double-walled indentation is formed. As an alternative the walls 4 and 5 can also be coated with a solder, and after the indentation 10 is formed they can be soldered together by heat treating the solder and the component 2 and hollow profile 3 in an oven.
The hollow profile 3 itself can be made from pipe skelp rolled and then welded along the seam. In like manner, extruded or rolled shapes can be considered. However, two superimposed skelps can be shaped by means of internal high fluidic pressure, and the impression can be performed in an economic manner during or after formation by internal high fluidic pressure. The hollow profile 3 can have a circular cross section like the tubular raw material or it can have other cross-sectional shapes which can be obtained by flattening, bending and pressing or the like.

Otherwise, the indentation 10 can also run like an annular groove around the component 2 and the hollow profile 3. The compression means can be the pressure column 25 as well as a segmented annular die surrounding component 2 as well as hollow profile 3.

Moreover, an additional advantage of the embodiments in Figures 4 and 7 should be mentioned at this point. As a result of the high internal pressure, when the walls 4 and 5 are forced in by the plunger 8 or the pressure column 25, due to the resistance offered by the high internal pressure, no sinking deformations with great bending radii are formed in the marginal area adjacent the indentation 10 to the detriment of the dimensional stability of the external shape of the hollow profile 3. Thus, the shape of the contour remains unaffected by the forcing inward, which among other things satisfy requirements as to the external appearance of the assembly of the hollow profile 3 to the component 2.